SPECIFICATION AMENDMENTS

The following incorporates the materials previously informally faxed to the Examiner on March 3, 2004 which were titled SUPPLEMENTAL AMENDMENT.

In reviewing the application, Applicant's attorney has discovered a duplication of the numeral 346.

The following amendment to the specification at pages 33-34 and to Fig. 15 is solely for the purpose of eliminating the duplication of the numeral 346 and substituting the numeral "348" for reference to the dark interval.

The Examiner's approval of the requested amendment to the drawings and to the specification is respectfully requested.

A marked up copy of Fig. 15 showing the proposed change in red is attached hereto.

IN THE SPECIFICATION

Please amend the paragraph beginning at page 33 line 2 through page 34 line 19 as follows:

The paper **100** is moving through the inspection zone **306** at a speed of 1,500 feet per minute which is equal to 300 inches per second. The size of each pixel **336** is determined by the observation area of one of the sensors **64** which is a circular area having a diameter from about ¾" to 1". Thus each pixel can be considered to have a length **342** and a width **346**, each of about ¾". If the cycle time between repetitions of the sequence of interrogating lights is set at 2,500 microseconds, the process will repeat 400 times per second, and thus, adjacent rows of pixels **336** and **338** will repeat every ¾" and will abut as shown in Fig. 13. Fig. 15 is a schematic illustration of the timing of these various pulses as they would appear if displayed on an oscilloscope screen. Each pulse of one of the light emitting diodes last for a duration of 50 microseconds. The LED flashes begin 80 microseconds apart. The time interval between the center line of adjacent pixels **336A** and **338A** is 2,500 microseconds.. The 2,500 microsecond time that it takes a given pixel length **342** to pass across a point in the inspection zone **36** is divided as follows. There are eleven periods of LED flashing to provide the first sequence of infrared from gloss source **152**, infrared from first source **12**, red, green, blue, then dark, then blue, then green, then red, then infrared from source **12**, and then infrared from source **152**. Each pulse has a duration of 50 microseconds and there is an interval of 80

microseconds between the beginning of adjacent pulses, thus resulting in a total of 880 microseconds during which the various lights are flashing. This leaves 1,620 microseconds during which no light from either of the sources is illuminating the inspection zone. With reference to Fig. 13, it will be appreciated that because the paper is moving, the receiver **14** will actually examine light received from an area slightly longer in length than the ¾" length **342** which is being examined at any given point in time, because of the fact that the paper moves a short distance during the 880 microsecond duration of the series of eleven flashes. The actual ¾" length area being analyzed by the sequential series of flashes is best conceptualized as being the ¾" long area which the receiver **14** examines during the "dark" interval **348** ~~**346**~~ in between the first series of flashes and the second reverse order series of flashes. Because the nested pairs of flashes of each color on either side of the dark interval **348** ~~**346**~~ are averaged, they represent the reflected intensity of each of those colors that would have occurred at the spot being observed during the dark interval **348** ~~**346**~~ if the paper had in fact not been moving. As can be seen in the example just described, the first and second series of sequential flashes are performed during an interrogation time interval of 880 microseconds which is less than the 2,500 microsecond time required for a pixel of an object equal in size to the inspection zone to move through the inspection zone.

RESTATED CLAIMS

Claim 1 (original): A method of sorting paper, comprising:

(a) conveying the paper through an inspection zone;

(b) analyzing at least the following three characteristics of the paper passing through the inspection zone:

(1) the color of the paper;

(2) whether the paper is glossy; and

(3) whether the paper displays printed material; and

(c) sorting the paper based upon at least one of the characteristics analyzed in step (b).

Claim 2 (original): The method of claim 1, further comprising:

providing a logic map specifying values of parameters corresponding to the three characteristics for a plurality of categories of paper; and

wherein step (b) includes determining the parameters for paper of unknown category passing through the inspection zone, and comparing the parameters for the paper of unknown category to the values in the logic map and thereby determining the category of the paper passing through the inspection zone.

Claim 3 (original): The method of claim 2, further comprising:

selecting a category of paper to be sorted from the other paper being conveyed through the inspection zone.

Claim 4 (original): The method of claim 2, wherein:

step (b) includes measuring an intensity of light reflected from the paper and originating from first and second light sources of different colored light.

Claim 5 (original): The method of claim 4, wherein:

the parameters of the logic map include a log slope of intensities of the reflected light from the first and second sources.

Claim 6 (original): The method of claim 4, wherein:

the parameters of the logic map include a color derivative representative of a difference in color of adjacent portions of the paper in the inspection zone.

Claim 7 (original): The method of claim 4, wherein:

the parameters of the logic map include a combined intensity of the reflected light from the first and second sources.

Claim 8 (original): The method of claim 4, wherein:

the parameters of the logic map include an intensity derivative representative of a difference in the presence of printed matter on adjacent portions of the paper in the inspection zone.

Claim 9 (original): The method of claim 2, wherein:

the parameters of the logic map include an intensity derivative representative of a difference in the presence of printed matter on adjacent portions of the paper in the inspection zone.

Claim 10 (original): The method of claim 2, wherein:

step (b) includes measuring an intensity of reflected light reflected from the paper and originating from first and second light sources of the same color light, the first and second light sources being differently oriented so that the measured reflected light from the first source is diffuse reflected light and the measured reflected light from the second source is directly reflected light.

Claim 11 (original): The method of claim 10, wherein:

the parameters of the logic map include a comparison of the diffuse reflected light from the first source with the direct reflected light from the second source.

Claim 12 (original): An apparatus for sorting paper, comprising:

a conveyor for conveying paper through an inspection zone;

a light source for transmitting light onto paper in the inspection zone;

a sensor for receiving light reflected from the paper in the inspection zone;

a paper analysis system, operably connected to the sensor for receiving the reflected light signals therefrom, the system including a color determination component, a glossiness determination component, and a printed matter determination component; and

a sorting mechanism including a select path and a reject path, the sorting mechanism being operably connected to the paper analysis system for sorting paper in response to the analysis conducted by the paper analysis system.

Claim 13 (original): The apparatus of claim 12, wherein the paper analysis system comprises:

stored data corresponding to predetermined values of parameters corresponding to color, glossiness and the presence of printed matter for a plurality of categories of paper.

Claim 14 (original): The apparatus of claim 13, wherein:

the color determination component, the glossiness determination component, and the printed matter determination component each are constructed to determine parameters for paper of unknown category passing through the inspection zone and compare the parameters of the paper of unknown category to the stored data.

Claim 15 (original): The apparatus of claim 12, further comprising:

a human interface system, including a plurality of pre-defined options for sorting of pre-defined categories of paper, so that a human operator of the apparatus may select one of the pre-defined options to be implemented by the paper analysis system and the sorting mechanism.

Claim 16 (original): The apparatus of claim 15, wherein:

the human interface system includes a sort selection screen having a single selection associated with each pre-defined option.

Claim 17 (original): The apparatus of claim 12, wherein the light source comprises:

a red light emitting diode, a green light emitting diode, and a blue light emitting diode; and

a controller which sequentially flashes the red, green and blue light emitting diodes.

Claim 18 (original): The apparatus of claim 17, wherein:

the paper analysis system compares reflected intensities of the red, green and blue lights to determine the color of paper in the inspection zone.

Claim 19 (original): The apparatus of claim 18, wherein:

the paper analysis system includes a color derivative detector for identifying differences in color of adjacent portions of a piece of paper in the inspection zone indicative of the presence of printed matter on the paper.

Claim 20 (original): The apparatus of claim 12, wherein:

the light source includes first and second light emitting diodes of the same color oriented so that the sensor receives diffuse reflected light from the first light emitting diode and directly reflected light from the second light emitting diode; and

the paper analysis system includes a glossiness detector which compares an intensity of the diffuse reflected light to an intensity of the directly reflected light.

Claim 21 (original): The apparatus of claim 12, wherein:

the paper analysis system includes an intensity derivative detector for identifying differences in intensity of reflected light from adjacent portions of a piece of paper in the inspection zone indicative of the presence of printed matter on the paper.

Claim 22 (original): The apparatus of claim 12, wherein:

the sensor includes a cylindrical bore having an irregular internal surface for deflecting incoming light that is substantially non-parallel to a central axis of the housing.

Claim 23 (original): The apparatus of claim 22, wherein:

the irregular internal surface is threaded.

Claim 24 (original): A high speed method of sorting paper, comprising:

(a) conveying the paper through an inspection zone at a speed of at least 1,000 feet per minute;

(b) analyzing at least one characteristic of the paper passing through the inspection zone, the at least one characteristic being selected from the group consisting of color, glossiness and the presence of printed matter; and

(c) sorting the paper downstream of the inspection zone based upon the analysis of step (b).

Claim 25 (original): The method of claim 24, wherein the speed in step (a) is at least 1,500 feet per minute.

Claim 26 (original): The method of claim 24, further comprising:

exposing the paper in the inspection zone to a plurality of separate sources of visible light of different wavelengths;

wherein step (b) includes analyzing the color of the paper based upon a comparison of the paper's reflectivity of the different wavelengths of visible light; and

wherein step (c) includes sorting the paper based upon the color of the paper.

Claim 27 (original): The method of claim 26, wherein:

step (b) includes analyzing whether the paper is glossy; and

step (c) includes sorting the paper depending upon whether the paper is glossy.

Claim 28 (original): The method of claim 26, wherein:

step (b) includes analyzing whether the paper has a printed surface; and

step (c) includes sorting the paper based upon whether the paper has a printed surface.

Claim 29 (original): The method of claim 24, further comprising:

collecting diffuse reflected light reflected off the paper from a first light source;

collecting dielectric reflected light reflected off the paper from a second light source;

wherein step (b) includes analyzing the glossiness of the paper based upon a comparison of the diffuse reflected light to the dielectric reflected light; and

wherein step (c) includes sorting the paper based upon the glossiness of the paper.

Claim 30 (original): The method of claim 24, further comprising:

comparing intensities of the light reflected from adjacent pixels of the paper within the inspection zone to identify paper with a varying reflectance from adjacent pixels resulting from the presence of printed matter on the paper; and

wherein step (c) includes sorting the paper based upon the presence of printed matter on the paper.

Claim 31 (original): A method of sorting paper, comprising:

(a) moving the paper through an inspection zone;

(b) exposing the paper in the inspection zone to a plurality of separate beams of visible light of different wavelengths;

(c) analyzing a color of the paper based upon a comparison of the paper's reflectivity of the different wavelengths of visible light; and

(d) sorting the paper downstream of the inspection zone based upon the color of the paper.

Claim 32 (original): The method of claim 31, wherein:

in step (b), the plurality of separate beams of visible light include a red light, a blue light and a green light.

Claim 33 (original): The method of claim 32, wherein:

the red, green and blue lights are emitted from red, green and blue light emitting diodes.

Claim 34 (original): The method of claim 32, wherein:

step (c) includes computing log slopes based upon ratios of the logs of the reflectivity of the different colored lights.

Claim 35 (original): The method of claim 32, wherein:

step (c) includes computing a visible intensity representative of the combined reflectivity of red, green and blue light.

Claim 36 (original): The method of claim 35, wherein:

step (c) includes computing an intensity derivative representative of a difference in visible intensity of reflected light for adjacent areas within the inspection zone, and thereby identifying the presence of printed matter on the paper.

Claim 37 (original): The method of claim 32, wherein:

step (c) includes computing a color derivative representative of a difference in color of adjacent areas within the inspection zone, and thereby identifying the presence of printed matter on the paper.

Claim 38 (original): The method of claim 31, wherein:

step (b) includes sequentially exposing the paper in the inspection zone to the plurality of separate beams of visible light of different wavelengths in a first sequence and then in a second sequence which is a reverse of the first sequence, so that two reflected light signals are generated for each wavelength of light; and

step (c) includes combining the analysis of the two reflected light signals for each wavelength of light to correct for dynamic aberration of the sensed color of the paper moving within the inspection zone.

Claim 39 (original): The method of claim 38, wherein:

the combined analysis in step (c) includes averaging the two reflected light signals.

Claim 40 (original): The method of claim 38, wherein:

step (b) includes an interval of no exposure from any of the separate beams of visible light between the first and second sequences.

Claim 41 (original): The method of claim 38, wherein:

the plurality of separate beams of visible light of different wavelengths includes a red light, a green light and a blue light.

Claim 42 (original): The method of claim 41, wherein:

step (b) further includes exposing the paper in the inspection zone to infrared light.

Claim 43 (original): A method of analyzing a color of a moving object, comprising:

(a) moving an object within an inspection zone;

(b) sequentially interrogating the inspection zone with multiple light sources of different light wavelengths as the object moves within the inspection zone, the interrogation including a first series of sequential flashes of the multiple light sources in a first order, followed by a second series of sequential flashes of the multiple light sources in a second order which is the inverse of the first order; and

(c) analyzing reflections of the multiple light sources from the paper, the analyzing including consideration of two reflections originating from each light source, one of the two reflections occurring during the first series and the other of the two reflections occurring during the second series.

Claim 44 (original): The method of claim 43, wherein:

the consideration of two reflections in step (c) includes averaging the two reflections.

Claim 45 (original): The method of claim 43, wherein:

step (b) includes an interval of no light flashes from any of the multiple sources between the first and second series.

Claim 46 (original): The method of claim 43, wherein:

the multiple light sources used in step (b) include a source of red light, a source of green light, and a source of blue light.

Claim 47 (original): The method of claim 46, wherein:

the multiple light sources used in step (b) further includes a source of infrared light.

Claim 48 (original): The method of claim 43, wherein:

the consideration of two reflections originating from each light source in step (c) corrects for dynamic aberration of the sensed color of the object moving within the inspection zone and thereby approximates a true color of the object.

Claim 49 (original): The method of claim 43, wherein:

in step (b) the first and second series of sequential flashes are performed during an interrogation time interval less than a time required for a pixel of an object equal in size to the inspection zone to move through the inspection zone.

Claim 50 (original): The method of claim 43, wherein the object is a piece of paper in a stream of waste paper.

Claim 51 (original): The method of claim 50, wherein:

step (a) includes moving the stream of waste paper through the inspection zone at a speed in excess of 1,000 feet per minute.

Claim 52 (original): The method of claim 51, wherein the speed is in excess of 1,500 feet per minute.

Claim 53 (original): A paper sorting apparatus, comprising:

a conveyor for conveying paper through an inspection zone, the conveyor having a width;

a light transmitter for transmitting light onto paper in the inspection zone, the light transmitter including an array of red lights, an array of green lights and an array of blue lights, each array being spaced across the width of the conveyor; and

a light receiver for receiving light reflected from paper in the inspection zone, the light receiver including an array of sensors spaced across the width of the conveyor, each sensor receiving light reflected from an area defining one pixel of the paper.

Claim 54 (original): The apparatus of claim 53, further comprising:

a control system for flashing the red, green and blue lights in a first sequence and then in second sequence which is the reverse of the first sequence; and

an analysis system for analyzing both the first and second sequence reflections of each of the red, green and blue lights from each pixel of the paper to approximate the true color of that pixel.

Claim 55 (original): The apparatus of claim 53, wherein:

the light transmitter and the light receiver are both located above the conveyor.

Claim 56 (original): The apparatus of claim 55, further comprising:

a mirror arranged so that the light from the transmitter reflects off of the mirror onto the inspection zone, and the light reflected from paper in the inspection zone reflects off of the mirror into the light receiver.

Claim 57 (original): The apparatus of claim 56, further comprising:

a reference surface located above the transmitter;

wherein the mirror is pivoted so that it can move between an operating position in which the light from the transmitter is reflected onto the inspection zone, and a normalization position in which light from the transmitter is reflected onto the reference surface.

Claim 58 (original): The apparatus of claim 57, further comprising:

a transparent wear cover located between the mirror and the conveyor; and

a reference wear cover located between the mirror and the reference surface.

Claim 59 (original): The apparatus of claim 53, further comprising:

a control system for flashing the red, green and blue lights in a sequence; and

an analysis system for analyzing the reflections of each of the red, green and blue lights from each pixel of the paper to determine a color of that pixel.

Claim 60 (original): The apparatus of claim 59, wherein:

the analysis system includes a means for comparing the intensities of reflected red, green and blue light from each pixel.

Claim 61 (original): The apparatus of claim 60, wherein:

the analysis systems includes a means for computing a combined intensity of the reflected red, green and blue light from each pixel.

Claim 62 (original): The apparatus of claim 61, wherein:

the analysis system includes a means for computing a difference in combined intensity for adjacent pixels to identify the presence of printed matter on the paper.

Claim 63 (original): The apparatus of claim 60, wherein:

the analysis system includes a means for identifying a color difference between adjacent pixels to identify the presence of printed matter on the paper.

Claim 64 (original): The apparatus of claim 53, wherein:

the sensor includes a cylindrical housing having an irregular internal surface for deflecting incoming light that is substantially non-parallel to a central axis of the housing.

Claim 65 (original): The apparatus of claim 64, wherein:

the irregular internal surface is threaded.

Claims 66-83 (canceled)

Claim 84 (original): A method of sorting paper, comprising:

(a) conveying paper through an inspection zone;

(b) transmitting light from an array of light sources onto a mirror;

(c) reflecting light from the mirror onto the inspection zone and off paper in the inspection zone back to the mirror;

(d) receiving light from the mirror in an array of sensors which sensors generate signals corresponding to characteristics of the paper in the inspection zone;

(e) moving the mirror to a normalization position wherein light from the array of light sources is reflected from the mirror onto a reference surface; and

(f) normalizing outputs from the array of sensors with reference to light reflected off the reference surface.

Claim 85 (original): The method of claim 84, wherein:

in step (c), light passing between the mirror and the inspection zone passes through a transparent wear cover; and

when the mirror is in the normalization position, light passing between the mirror and the reference surface passes through a reference wear cover of light transmissive properties equal to those of the transparent wear cover.

Claim 86 (original): The method of claim 84, wherein:

steps (e) and (f) are automatically performed on a periodic basis.

Claim 87 (original): The method of claim 84, wherein:

steps (e) and (f) are performed upon startup of the method.

Claim 88 (original): The method of claim 84, wherein:

in step (a), the paper is conveyed on a black conveyor belt; and

in step (e), the reference surface is white.